How to create a **Devcontainer** for your Python project 🐳

Jeroen Overschie

Machine Learning Engineer

GoDataDriven

The use case

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→ otherwise we do not enjoy the guarantees we want in **production** code

PP

Petra the Python Dev

Hi my venv somehow got corrupted 🥲 . It's saying `No module named 'numpy'` even though I seemingly have it installed. Not sure how to fix.

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I'm trying to dockerize the project but it's haaard. Everything that works on my Windows laptop seems to fail on Linux.

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JJ **Johnny Junior**
Good day. I'm new at the company and wanted to get started working on the repo. Tried following the README steps but doesn't work. By any chance: are there any more detailed docs available for project setup? No right? 🙃

🐛 Issues

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Petra the Python Dev

Corrupted Virtual Environment

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🔄 How to get a **reproducible** Dev environment?

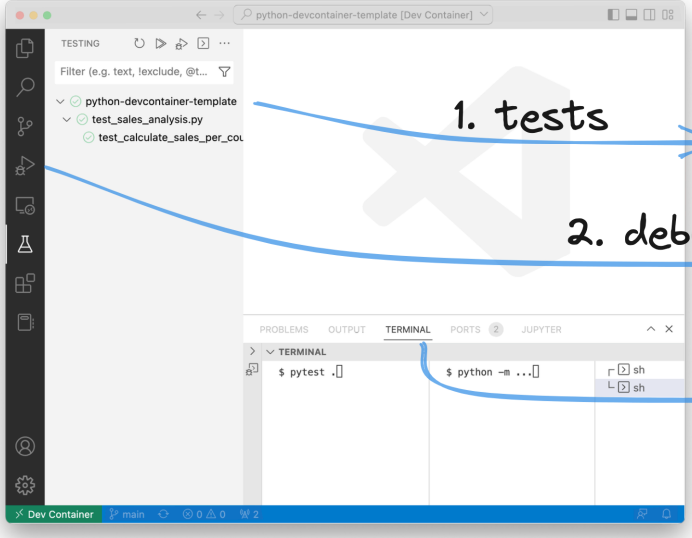
Devcontainers to the rescue  !

Devcontainers to the rescue ⛑️!

🐋 **Docker** helps us create a formal definition of our environment.

🔌 **Devcontainers** allow you to connect your editor (IDE) to that container.

Develop in your IDE,
but run ...



... inside your
Docker container

- ✅ reproducibility
- ✅ isolation
- ✅ native experience

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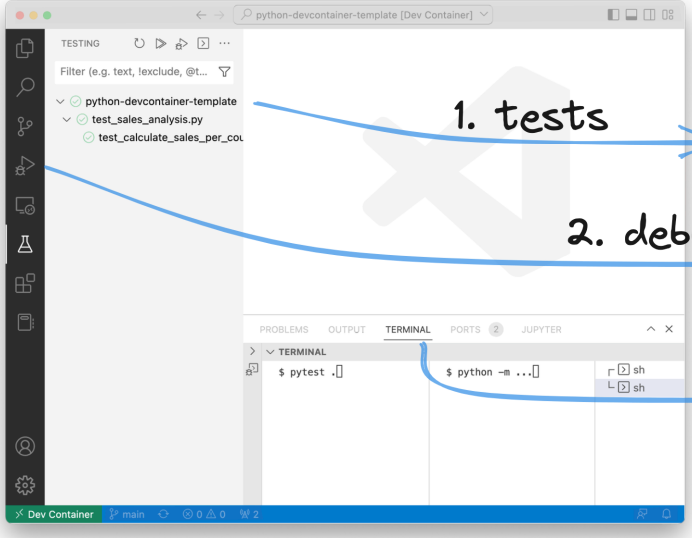

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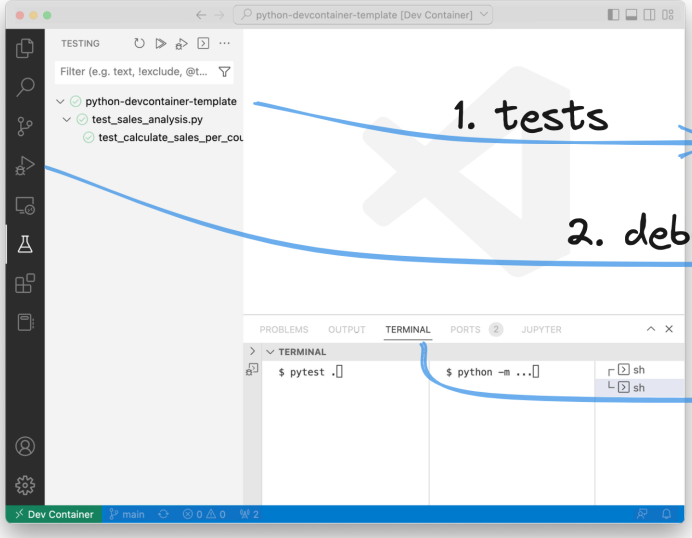

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- ⚡ Faster onboarding

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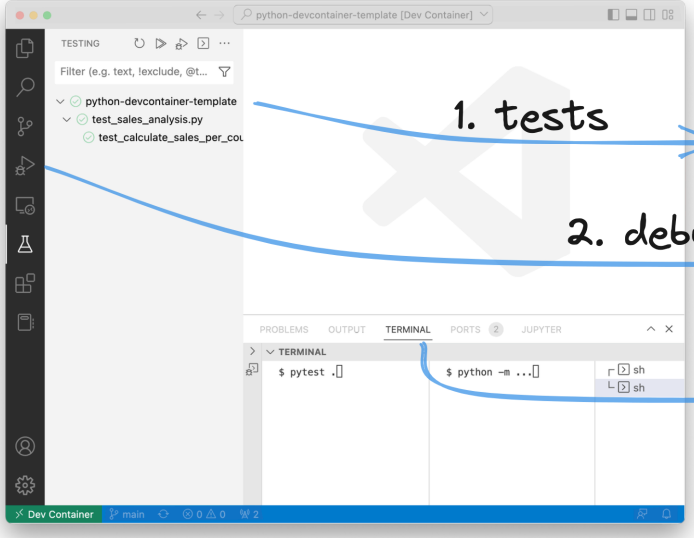

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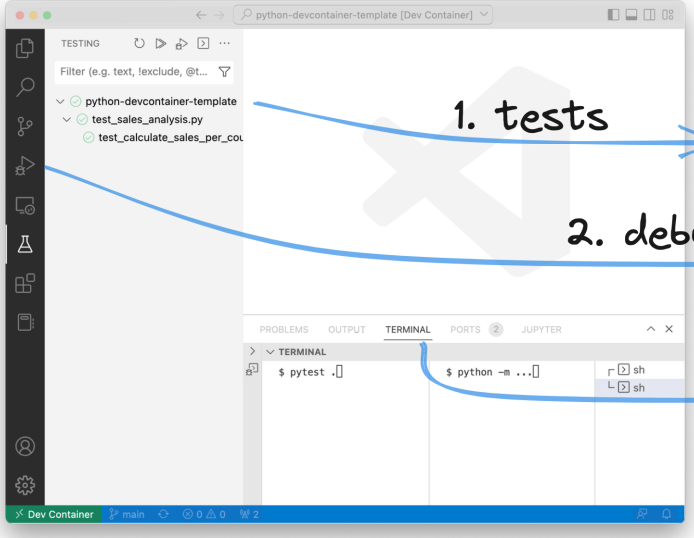

1. tests

2. debugging

3. terminal

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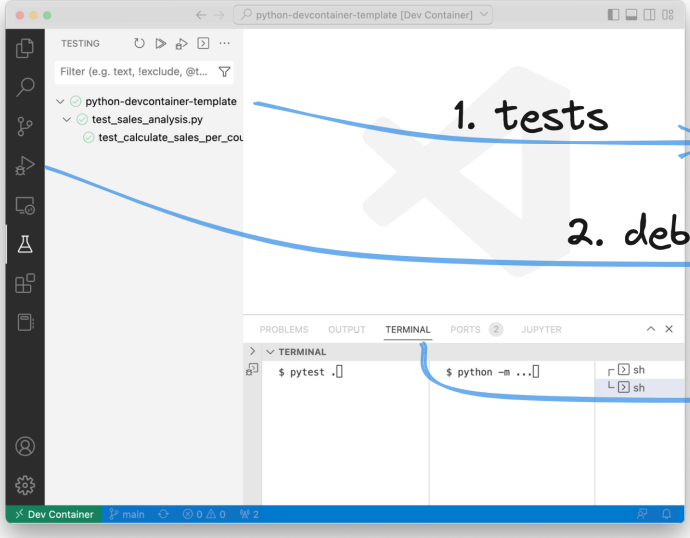

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Downsides?

- Docker knowledge

 Let’s build a Devcontainer!

Let's say we have a really simple project that looks like this:

```
$ tree .
.
├── README.md
├── requirements.txt
├── requirements-dev.txt
├── sales_analysis.py
└── test_sales_analysis.py
```

The `.devcontainer` folder

Your Devcontainer spec will live inside the `.devcontainer` folder.

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There will be two main files:

- `devcontainer.json`
- `Dockerfile`

Create a new file called `devcontainer.json`:

```
{
    "build": {
        "dockerfile": "Dockerfile",
        "context": ".."
    }
}
```

So how does this `Dockerfile` look like?

```
1  FROM python:3.10
2
3  # Install Java
4  RUN apt update && \
5      apt install -y sudo && \
6      sudo apt install default-jdk -y
7
8  ## Pip dependencies
9  # Upgrade pip
10 RUN pip install --upgrade pip
11 # Install production dependencies
12 COPY requirements.txt /tmp/requirements.txt
13 RUN pip install -r /tmp/requirements.txt && \
14     rm /tmp/requirements.txt
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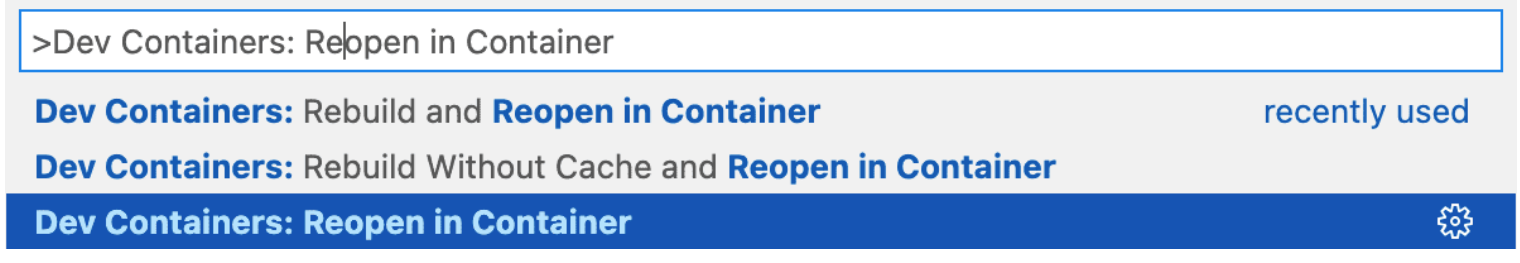
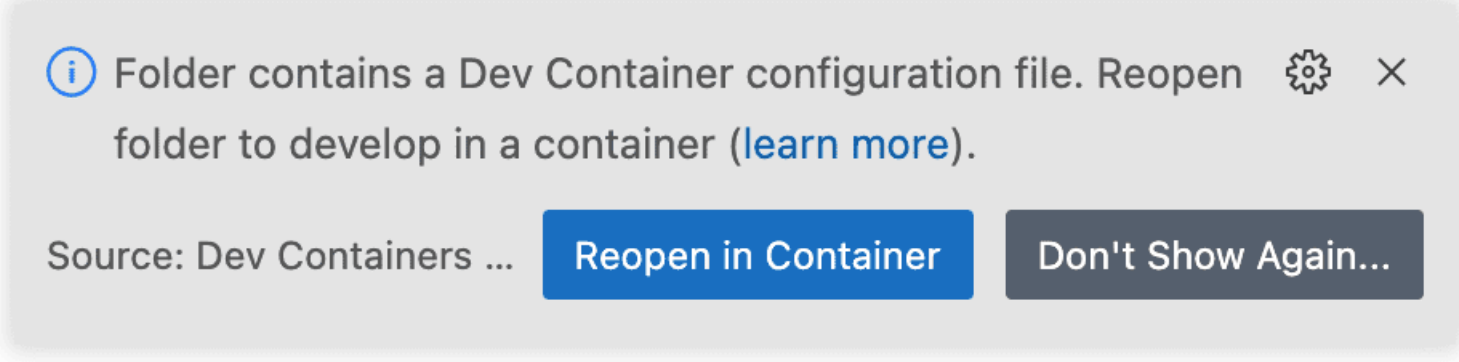
Opening the Devcontainer

The `.devcontainer` folder in place, now it's time to open our Devcontainer.

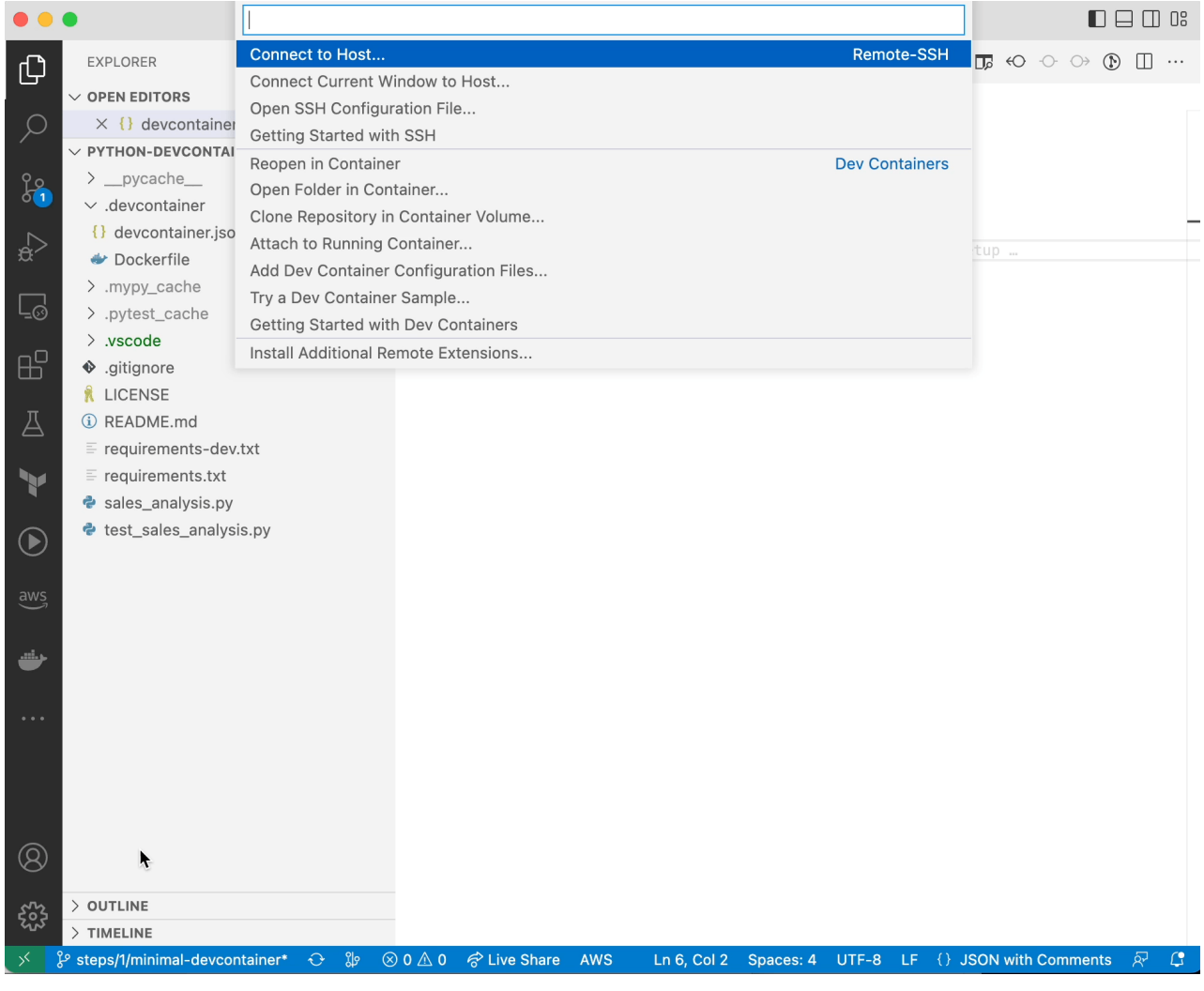
Open up the command pallete (`CMD` + `Shift` + `P`) and select "*Dev Containers: Reopen in Container*":



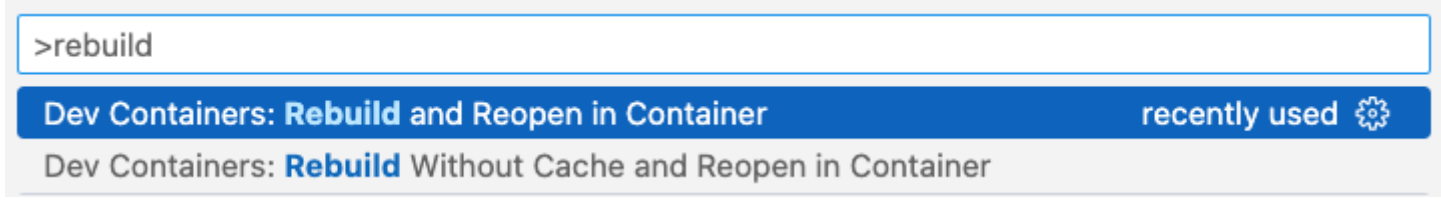
Upon opening a repo with a valid `.devcontainer` folder, you are already notified:



Your VSCode is now connected to the Docker container 🙌:



Rebuilding allows you to get a fresh environment anytime you want:



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1. **VSCode Server** is being installed on your Devcontainer.

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3. **Filesystem mounts**.

   VSCode automatically takes care of mounting:

   - The folder you are running the Devcontainer from.
   - Your VSCode workspace folder.

Opening your Devcontainer with the click of a button

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```
[
    ![Open in Remote - Containers](
        https://img.shields.io/static/v1?label=Remote%20-%20Containers&message=Open&color=blue&logo=visualstudioco
    )
](
    https://vscode.dev/redirect?url=vscode://ms-vscode-remote.remote-containers/cloneInVolume?url=https://github.com/godatadriven/python-devcontainer-template
)
```

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    )
](
    https://vscode.dev/redirect?url=vscode://ms-vscode-remote.remote-containers/cloneInVolume?url=https://github.com/godatadriven/python-devcontainer-template
)
```

Which basically means, open this URL:

```
vscode://
  ms-vscode-remote.remote-containers/
  cloneInVolume?
  url=https://github.com/godatadriven/python-
devcontainer-template
```

Just modify the GitHub URL after `url=` ✓.

This renders the following button:

What kind of README would you rather like?

49 lines (29 sloc) | 932 Bytes — Raw | Blame

Your fantastic repo

Hi! Welcome to the team ! Let's get you started quickly. This is what you have to do.

Installation

1. Install Java 11.0.16
2. Install Python 3.10.8

Virtual environment

There are a couple ways to go about this.

1. `pyenv`

   First, install pyenv using the pyenv-installer.

   Then, create a new environment using:

   ```
   pyenv shell 3.10.8
   pyenv virtualenv my-venv
   pyenv shell my-venv
   ```

2. Conda

   Install conda and create a virtualenv.

3. Python venv

   ```
   python -m venv venv
   source ./venv/bin/activate
   ```

pip packages

1. Make sure to `pip` install the following packages:
   - black
   - pytest
   - jupyter (not necessary when installing for CI or prod)
   - mypy

⚠️ Note: this is entire setup is known to work for Debian GNU/Linux 11 (bullseye), not tested for other Operating Systems.

15 lines (8 sloc) | 1 KB — Raw | Blame

Your fantastic repo

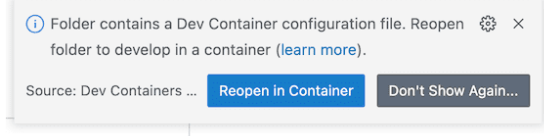
If you happen to use VSCode as your editor, you can open the repo in a **Devcontainer**. Devcontainers allow you to develop *inside* a Docker container - which means all dependencies and packages are automatically set up for you. First, make sure you have the Remote Development extension installed.

Then, you can do two things.

1. Click the following button:

2. Or, open up the repo in VSCode. Then, you should see the following notification:



That's it 🙌 Enjoy developing.

Extending the Devcontainer

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- Be able to access Spark UI (**opening up port 4040**)

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- Run **Continuous Integration** (CI) in the Devcontainer

Let's see how.

Installing a non-root user

If you `pip install` a new package, you will see the following message:

```
WARNING: Running pip as the 'root' user can result in broken permissions and conflict
ing behaviour with the system package manager. It is recommended to use a virtual env
ironment instead: https://pip.pypa.io/warnings/venv
```

So let's go ahead and create a user for this scenario.

```
# Add non-root user
ARG USERNAME=nonroot
RUN groupadd --gid 1000 $USERNAME && \
    useradd --uid 1000 --gid 1000 -m $USERNAME
## Make sure to reflect new user in PATH
ENV PATH="/home/${USERNAME}/.local/bin:${PATH}"
USER $USERNAME
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Add the following property to `devcontainer.json`:

```
"remoteUser": "nonroot"
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Add the following property to `devcontainer.json`:

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"remoteUser": "nonroot"
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That's great! When we now start the container we should connect as the user `nonroot`.

Passing custom VSCode settings

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```
"customizations": {
    "vscode": {
        "extensions": [
            "ms-python.python"
        ],
        "settings": {
            "python.testing.pytestArgs": [
                "."
            ],
            "python.testing.unittestEnabled": false,
            "python.testing.pytestEnabled": true,
            "python.formatting.provider": "black",
            "python.linting.mypyEnabled": true,
            "python.linting.enabled": true
        }
    }
}
```

Accessing Spark UI

Since we are using pyspark, it would be nice to be able to access **Spark UI**.

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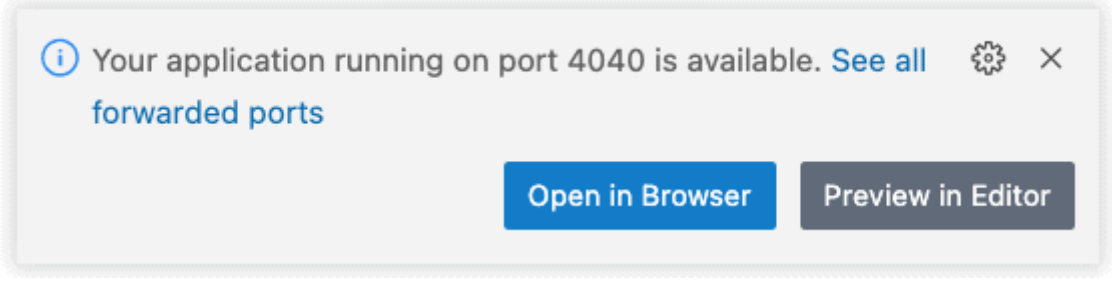
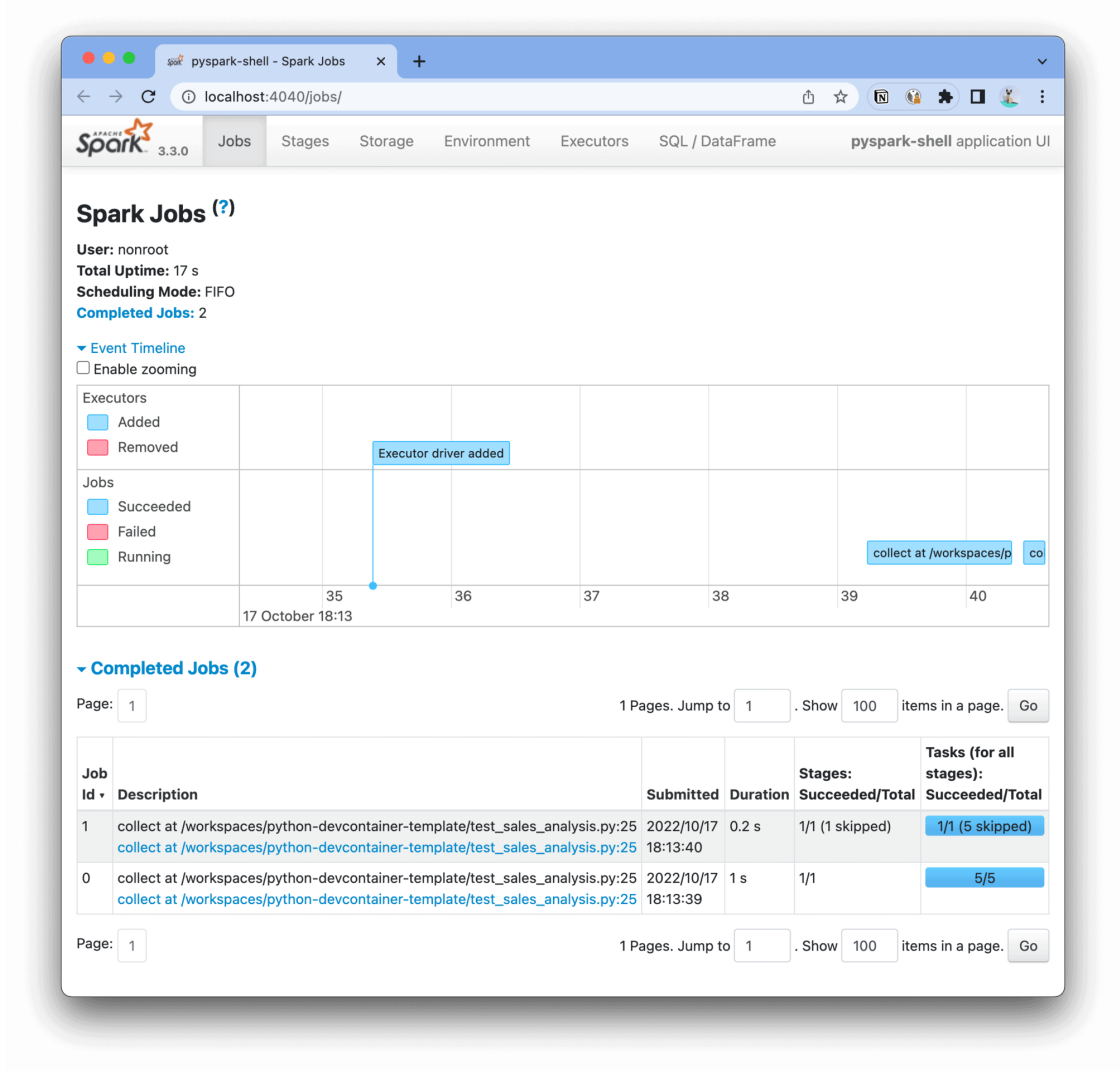
```
"portsAttributes": {
    "4040": {
        "label": "SparkUI",
        "onAutoForward": "notify"
    }
},

"forwardPorts": [
    4040
]
```

When we now run our code, we get a notification we can open Spark UI in the browser:



Resulting in the Spark UI like we know it:



Running our CI in the Devcontainer

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There are two basic options:

1. Build the Docker image *within* the CI/CD pipeline
2. Prebuilding the image

Let's see about option number (1).

1. Build the Docker image *within* the CI/CD pipeline

Luckily, a GitHub Action was already setup for us to do exactly this:

devcontainers/ci

To now build, push and run a command in the Devcontainer is as easy as:

```
1
2  name: Python app
3
4  on:
5    ...
6
7  jobs:
8   build:
9    runs-on: ubuntu-latest
10
11   steps:
12    - name: Checkout (GitHub)
13     uses: actions/checkout@v3
14
15    - name: Login to GitHub Container Registry
16     uses: docker/login-action@v2
17     with:
18      registry: ghcr.io
```

To now build, push and run a command in the Devcontainer is as easy as:

```yaml
    runs-on: ubuntu-latest

    steps:
      - name: Checkout (GitHub)
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      - name: Login to GitHub Container Registry
        uses: docker/login-action@v2
        with:
          registry: ghcr.io
          username: ${{ github.repository_owner }}
          password: ${{ secrets.GITHUB_TOKEN }}

      - name: Build and run dev container task
        uses: devcontainers/ci@v0.2
        with:
          imageName: ghcr.io/${{ github.repository }}/devcontainer
```
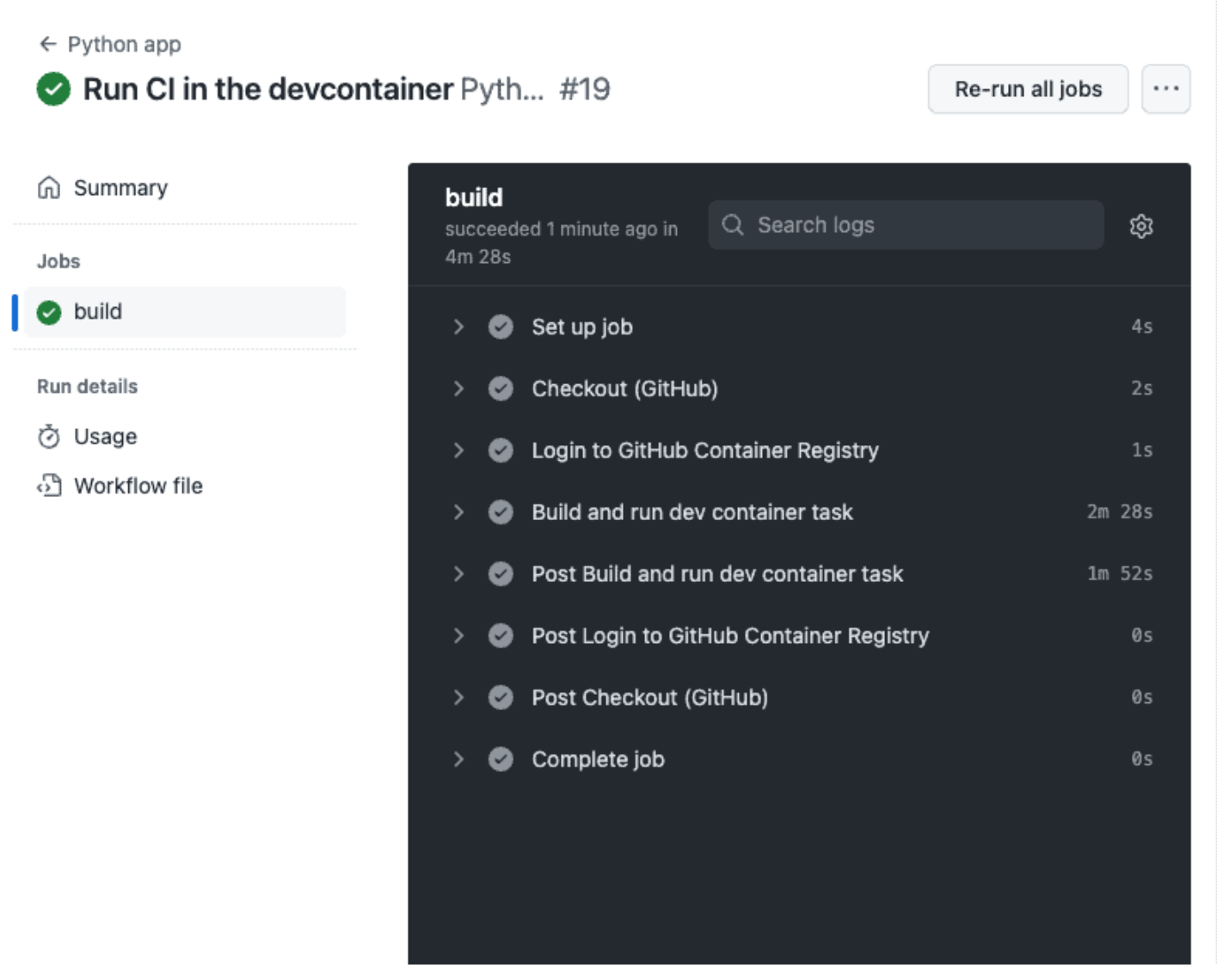

To now build, push and run a command in the Devcontainer is as easy as:

```
10
11    steps:
12     - name: Checkout (GitHub)
13       uses: actions/checkout@v3
14
15     - name: Login to GitHub Container Registry
16       uses: docker/login-action@v2
17       with:
18         registry: ghcr.io
19         username: ${{ github.repository_owner }}
20         password: ${{ secrets.GITHUB_TOKEN }}
21
22     - name: Build and run dev container task
23       uses: devcontainers/ci@v0.2
24       with:
25         imageName: ghcr.io/${{ github.repository
   }}/devcontainer
26         runCmd: pytest .
```

See below a trace of the executed GitHub Action:



Awesome!

The final Devcontainer definition

We built the following Devcontainer definitions.

First, `devcontainer.json`:

```
{
    "build": {
        "dockerfile": "Dockerfile",
        "context": ".."
    },

    "remoteUser": "nonroot",

    "customizations": {
        "vscode": {
            "extensions": [
                "ms-python.python"
            ],
            "settings": {
                "python.testing.pytestArgs": [
                    "."
                ],
                "python.testing.unittestEnabled": false,
                "python.testing.pytestEnabled": true,
                "python.formatting.provider": "black",
                "python.linting.mypyEnabled": true,
                "python.linting.enabled": true
            }
        }
    },
    ...
}
```

```
"portsAttributes": {
    "4040": {
        "label": "SparkUI",
        "onAutoForward": "notify"
    }
},

"forwardPorts": [
    4040
]
```

And our `Dockerfile`:

```
FROM python:3.10

# Install Java
RUN apt update && \
    apt install -y sudo && \
    sudo apt install default-jdk -y

# Add non-root user
ARG USERNAME=nonroot
RUN groupadd --gid 1000 $USERNAME && \
    useradd --uid 1000 --gid 1000 -m $USERNAME
## Make sure to reflect new user in PATH
ENV PATH="/home/${USERNAME}/.local/bin:${PATH}"
USER $USERNAME

## Pip dependencies
# Upgrade pip
RUN pip install --upgrade pip
# Install production dependencies
COPY --chown=nonroot:1000 requirements.txt /tmp/requirements.txt
RUN pip install -r /tmp/requirements.txt && \
    rm /tmp/requirements.txt
# Install development dependencies
COPY --chown=nonroot:1000 requirements-dev.txt /tmp/requirements-
dev.txt
RUN pip install -r /tmp/requirements-dev.txt && \
    rm /tmp/requirements-dev.txt
```

Going further 🔮

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- Mounting directories

  💡 Pro tip: mount your AWS/GCP/Azure credentials

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  e.g. GitHub Codespaces, VM's on Azure/GCP/AWS

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  e.g. GitHub Codespaces, VM's on Azure/GCP/AWS

... and much more (see references slide)

Concluding

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Now only VSCode, but open specification taking shape.


PP
EO
BW
PU
JJ


PP
EO
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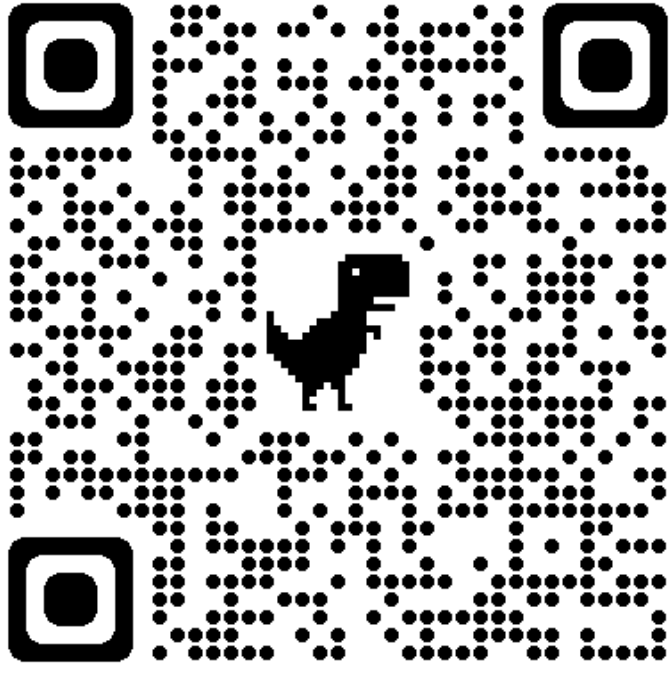
Thanks! 🙌🏻



github.com/godatadriven/python-devcontainer-template

Awesome resources

Associated blog post:

- How to create a Devcontainer for your Python project 🐋

Spec:

- containers.dev. The official Devcontainer specification.
    - Devcontainer templates
    - Devcontainer features

Docs:

- Dev Containers VSCode extension. The extension required to connect VSCode to a Devcontainer.
- Mounting file directories in Devcontainers.
- Add a non-root user to a container. More explanations & instructions for adding a non-root user to your `Dockerfile` and `devcontainer.json`.
- Pre-building dev container images

Repo's:

- github.com/devcontainers/ci. Run your CI in your Devcontainers. Built on the Devcontainer CLI.
- github.com/devcontainers/images. A collection of ready-to-use Devcontainer images.
- github.com/manekinekko/awesome-devcontainers. A repo pointing to yet even more awesome resources.